PCBs at the Top of the Food Chain: Geographical Variation in British Columbia and Washington Harbour Seals (*Phoca vitulina*)

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Marine mammals often occupy high trophic levels in aquatic food chains, and are therefore prone to accumulating high concentrations of fat-soluble toxic chemicals. Exposure to such contaminants as polychlorinated biphenyls (PCBs) dioxins (PCDDs) and furans (PCDFs) have been associated with endocrine disruption, reproductive impairment, immunotoxicity and developmental abnormalities in several marine mammal populations inhabiting European and North American coastal waters (Ross and others 1996a). While field studies have provided evidence for contaminant-associated adverse health effects, captive feeding studies have provided more definitive mechanistic information on links between contaminants and certain biological endpoints. Harbour seals (*Phoca vitulina*) fed fish from contaminated areas exhibited reproductive and immunological effects in two independent studies (Reijnders 1986; De Swart and others 1994; Ross and others 1996b).

We have been using harbour seals as sentinels of chemical contamination in southern British Columbia and Puget Sound, Washington for several years (Calambokidis and others 1991; Calambokidis and others 1984; Hong and others 1996; Ross and others 1997). This small pinniped is abundant in the coastal waters of the northern hemisphere, with population numbers estimated at 108,000 in British Columbia (Olesiuk 1999) and 17,000 in the inland waters of Washington State (Jeffries and others 1997). Harbour seals are omnivorous, consuming a wide variety of fishes as well as invertebrates. In the Strait of Georgia, they exhibit a strong preference for herring (*Clupea harengus*) and hake (*Meluccius productus*) (Olesiuk 1993); in Puget Sound, they appear to consume a wider diversity of fishes, including Pacific cod (*Gadus macrocephalus*), herring, plainfish midshipman (*Porichthys notatus*) and hake (Steve Jeffries, unpublished observations). Ongoing research into dietary preferences will assist in the tracking of sources of chemical contamination in this region.

Small blubber biopsy samples from young, free-ranging harbour seals inhabiting several areas in BC (Strait of Georgia: Victoria, Vancouver, Crofton, Hornby Island; Queen Charlotte Sound) and Washington (Puget Sound: Gertrude Island) have been analyzed for congener-specific PCBs, PCDDs and PCDFs. Blubber extracts were analyzed using high resolution gas chromatography / high resolution mass spectrometry at the Regional Dioxin Laboratory (Institute of Ocean Sciences, Sidney BC). Results suggest that the Puget Sound food chain is particularly contaminated with PCBs, with harbour seals being more than seven times more contaminated (18 mg/kg lipid) than Strait of Georgia seals (2.5 mg/kg lipid) or Queen Charlotte Sound seals (1.1 mg/kg lipid). A pulp mill-derived signature of contaminants (particularly PCDDs) was detectable in BC seals, although declining levels in Dungeness crab samples since regulations were implemented on the use of chlorine in the late 1980s suggest decreasing environmental levels (Yunker and others 1995). When the total “dioxin like” toxic risk is evaluated using Toxic Equivalent Factors (TEFs) to 2,3,7,8-TCDD (“dioxin” Toxic Equivalents or TEQ) for the PCBs, PCDDs and PCDFs (Van den Berg and others 1998), PCBs were found to represent the greatest risk to seals in both BC (64% of total TEQ) and Washington (91% of total TEQ).

Recent regulatory and industrial process changes have caused a reduction in the release of PCDDs and PCDFs from pulp mills into the coastal waters of BC and Washington. The persistent PCBs represent an ongoing concern to the health of wildlife in the waters of both British Columbia and Washington, as evidenced by the high levels observed here in Puget Sound seals, and the very high levels recently observed in Pacific killer whales (Ross and others 2000). We have also demonstrated that ambient contaminant levels are disrupting vitamin A (retinoid) physiology in harbour seal pups from both BC and Washington (Simms and others 2000). Given their persistence in the environment, the relative inability of marine mammals to metabolically eliminate them (Boon and others 1997), and their continued cycling in the global environment through atmospheric processes (Wilkening and others 2000), PCBs are likely to continue to present a risk to the health of high trophic level wildlife for several decades.

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